



Protecting critical infrastructure – The Tamperfighter SoP fibre sensing system

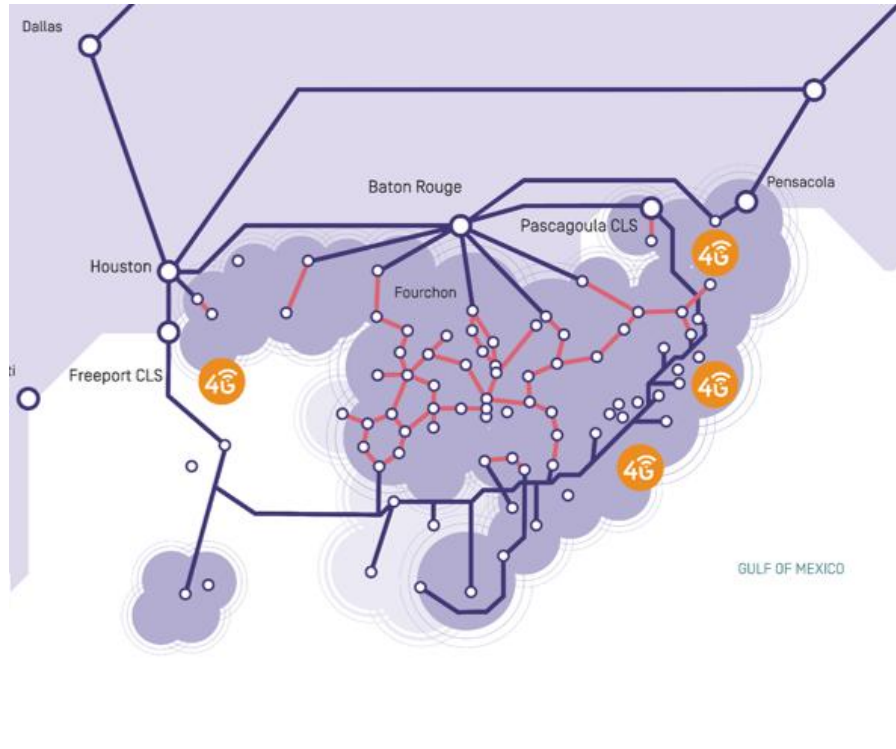
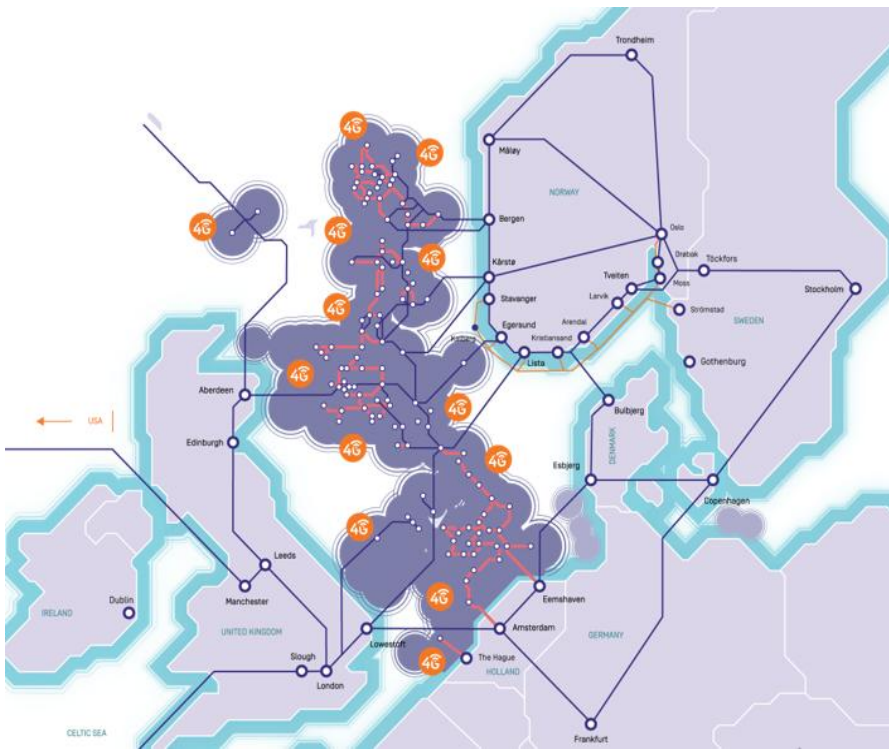
Steinar Bjørnstad - Tampnet AS

Owning and operating unique assets Offshore Europe and US










– Control of performance and resilience

Tampnet operates 100% of the fiber network in the NS (~68% owned, ~32% leased from energy majors)

Tampnet owns 100% of the fiber cable systems in the GoM – and expanding



Company facts

-  **Founded**
2001
-  **Owners**
3i & ATP
-  **CEO**
Elie Hanna
-  **Offshore installations**
450+
-  **Local Presence**
7 Countries
-  **Headquarters**
Stavanger
-  **Offshore Network**
600.000 km²
-  **Fibre Optic Network**
5,400 km
-  **Euro Turnover**
100 Million

North Sea infrastructure

Gulf of Mexico infrastructure

3,900km of subsea fiber 145+ microwave hops
50+ 4G LTE base stations ~250km² LTE coverage

1,500km of subsea fiber 40+ 4G LTE base stations
55+ microwave hops ~250km² LTE coverage

Multiple spectrum licenses in all markets



Fibre sensing

Outline

- Motivation
- Integrating SoP in communication systems
- SoP monitoring system
- Observations and analysis examples

State of Polarization (SoP) sensing –Use cases

- Change detection: Reliable alarms ensuring infrastructure availability and security
 - Movements or hits on the cable causing abnormal SoP variation
 - Displacement of the cable resulting from e.g. a hit.
- Detecting abnormal activity
 - Anchoring, trawling,
 - Subsea attacks
 - Land-slides and heavy earthquakes

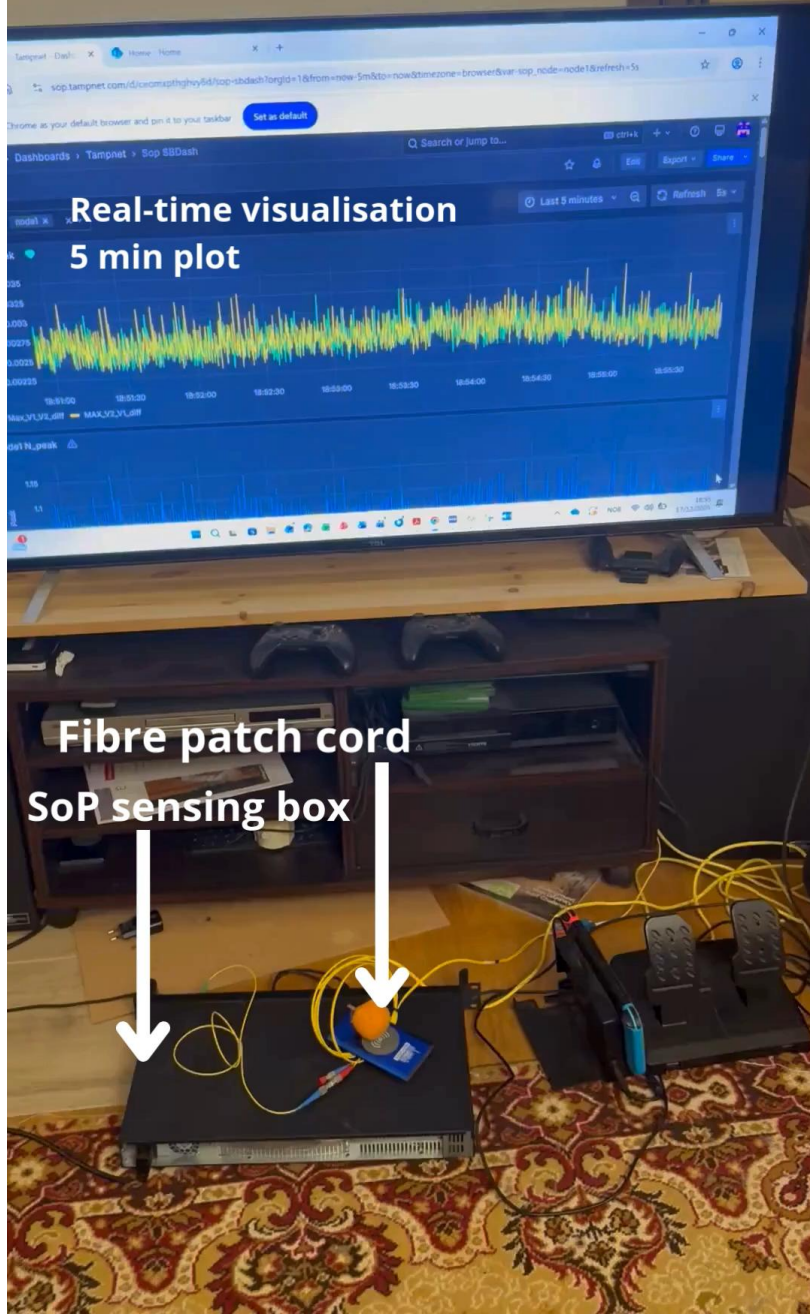
Fibre to the home State of Polarization (SoP) monitoring

Fibre sensing: SoP technology

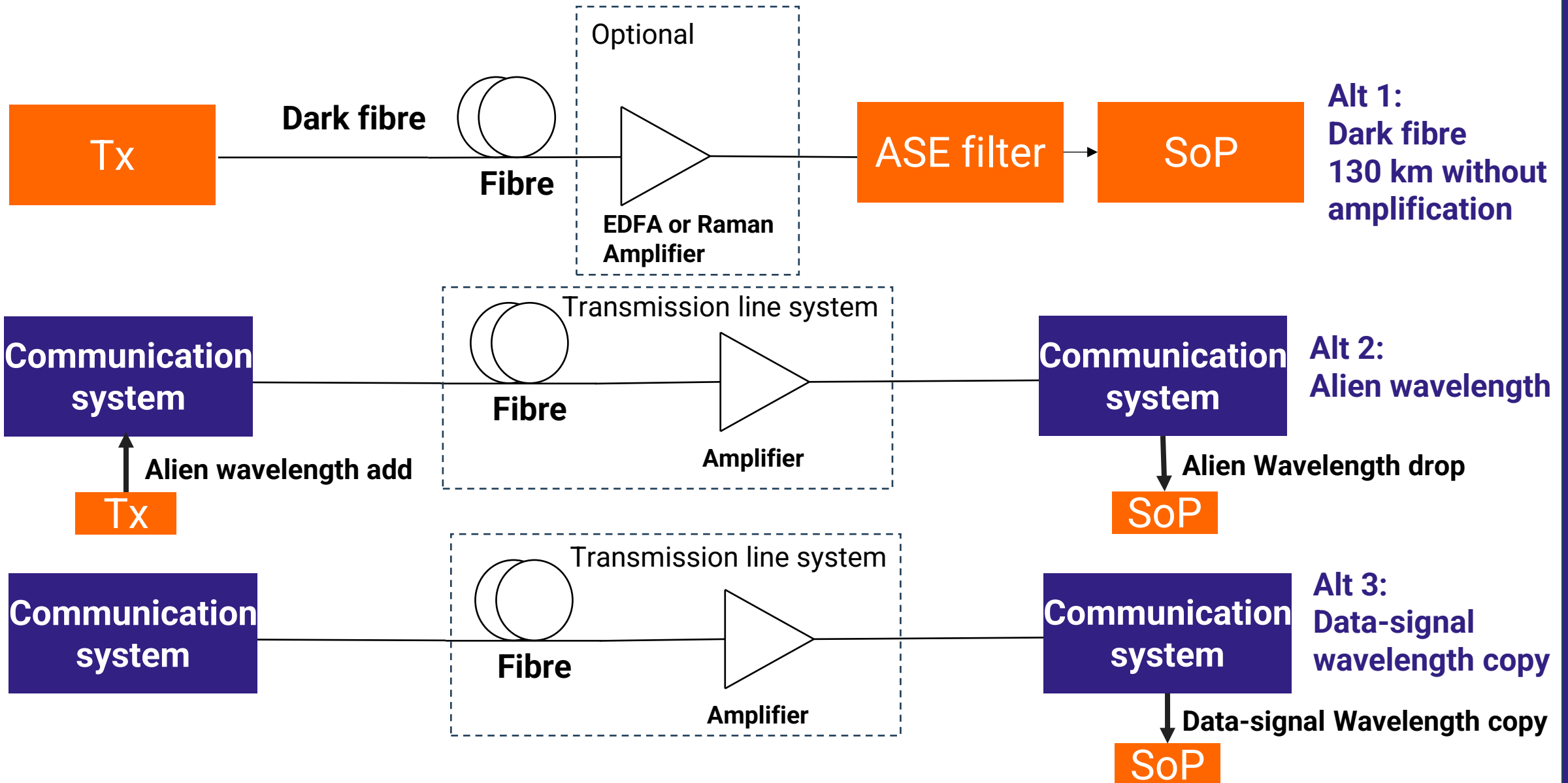
Detecting fibre infrastructure impacts

Freia and Minde at work – hunting for food!

- Moving a patch-cable
- Physical impact on cable → sends signal

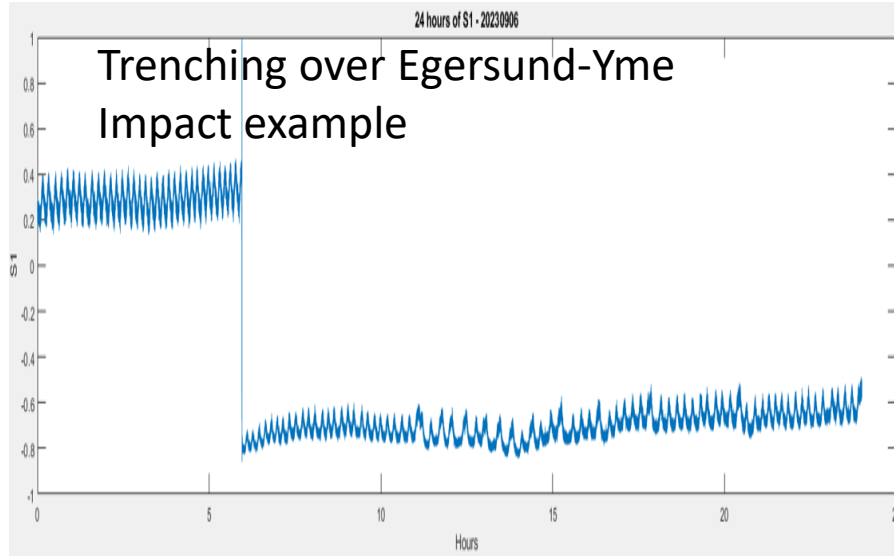


Flexible integration in the network



Tampnet Tamperfighter Polarisation (SoP) monitoring System dedicated to SoP monitoring in telecom

Monitor for impacts on fibrepaths



Correlation with other data sources for identification of events and position of events

- Tamperfighter Hardware
 - Optical input: -20 dBm Typical input power
 - Typical config: 44.1 kHz sampling frequency, 16 bit resolution.
 - Measure change in S0 and S1
 - 4 TB local storage, 1-2 years of data
 - Embedded software for edge processing
 - Synchronization to server and streaming of processed data
 - 4 X USB-A – Keyboard, mouse
 - 1 X RJ-45 – Ethernet
- 1U instrument for installation in node rooms – Telecom friendly.
 - LGX module for combination with filters, Transmitter etc.
 - 48 V power supply
- Collects data to central server (.flac format)
- Stream processed data to Network Operation Centre (NOC)
- Enabling monitoring and alarming in NOC

Digi.no & TU.no 18.12.25

DIGI

Ledige stillinger

Nyhetsbrev

Nyhetsstudio

Tips oss



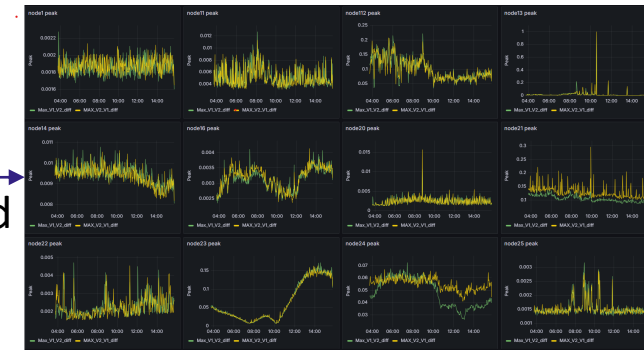
Ny fibersensorteknologi:

Nå kan norsk selskap overvåke 5400 km sjøkabel – i sanntid

Monitoring subsea
infrastructure in
real-time

Scaling fibre sensing: NORFEST example

Operation centre/NOC:
 Graphana GUI presentation of
 Processed data
 Alarm handling



External users
raw data access

Data collection server
Influx database

Processed data

SSH tunnel

Management
NOC access

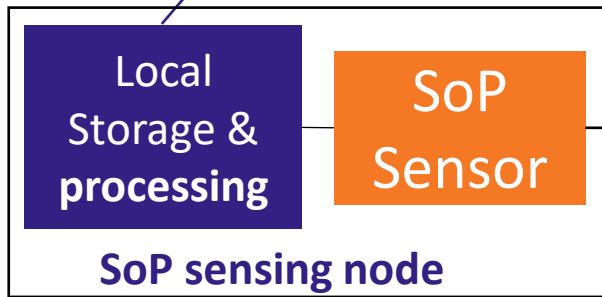
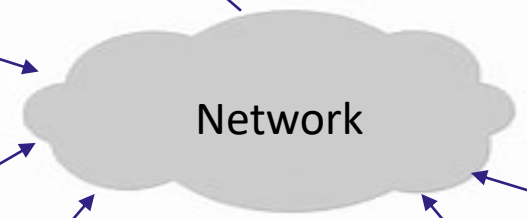
Aren.
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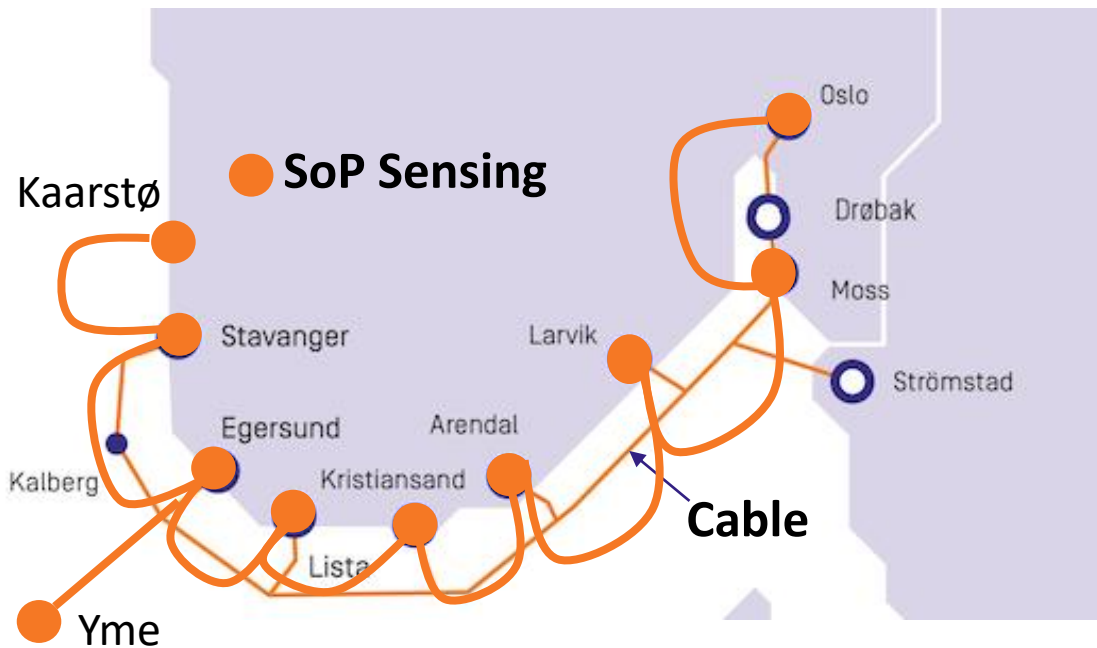


Edge computing reducing datavolume

NORFEST

SoP: Section by section monitoring

Proactive failure prevention



Scalability: Signals from many cables

- Cables give different signals and alarm conditions.
- Distributed processing (edge): Reduce data volume
- Centralized processing:
 - Correlating data sources
 - Shaping for different applications: Filtering and processing

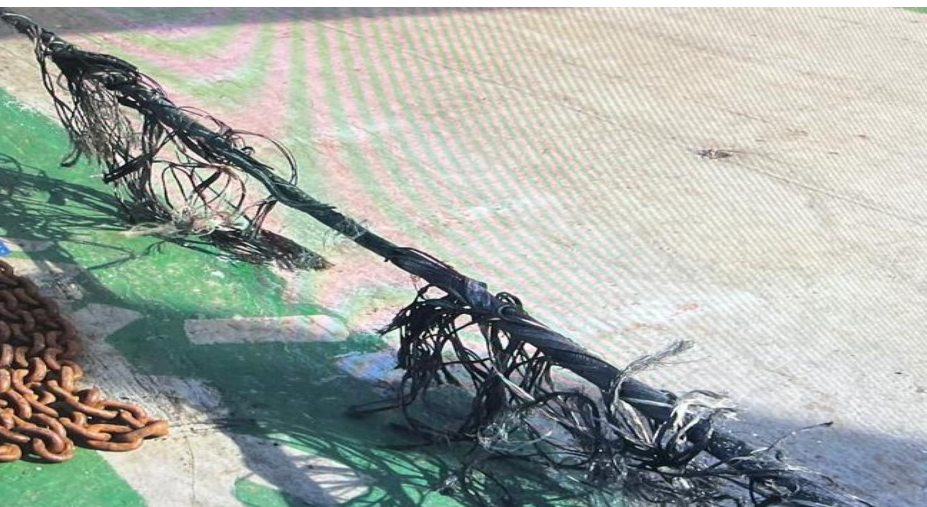


Graphana view: SoP downsampled signals real-time streaming from 12 different cables

Fibre sensing in telecom: main challenges

- Scaling to many sensing units and many cables
- Proactive alarming and action in Network Operations Centre (NOC)

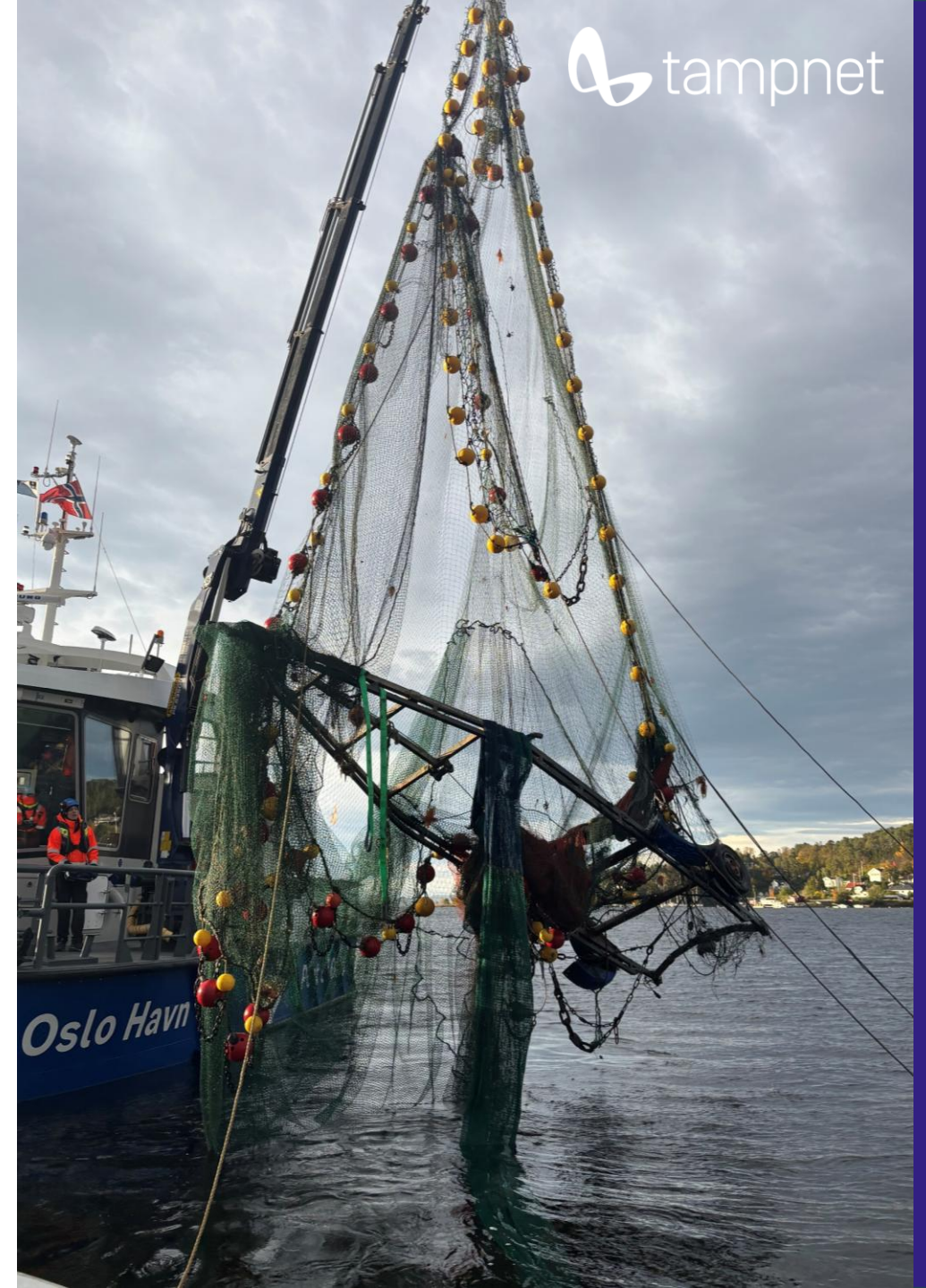
Avoid this:



Typically many hits
before a break occurs

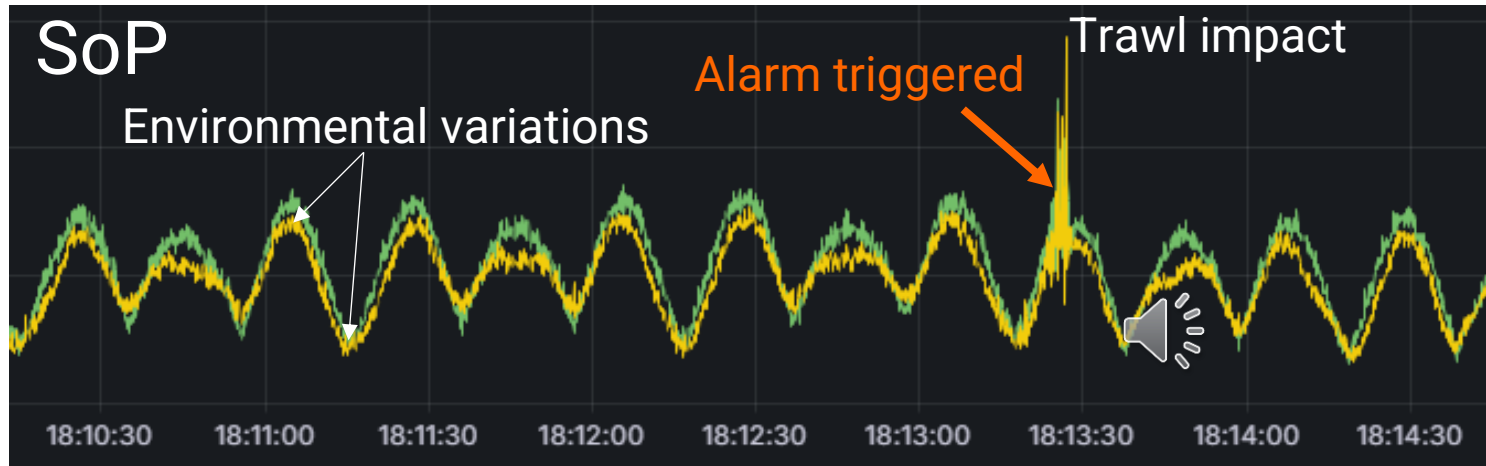


Fisherman pulling a trawl
that was thought to be
stuck on our cable. Turns
out it was a trailer frame!

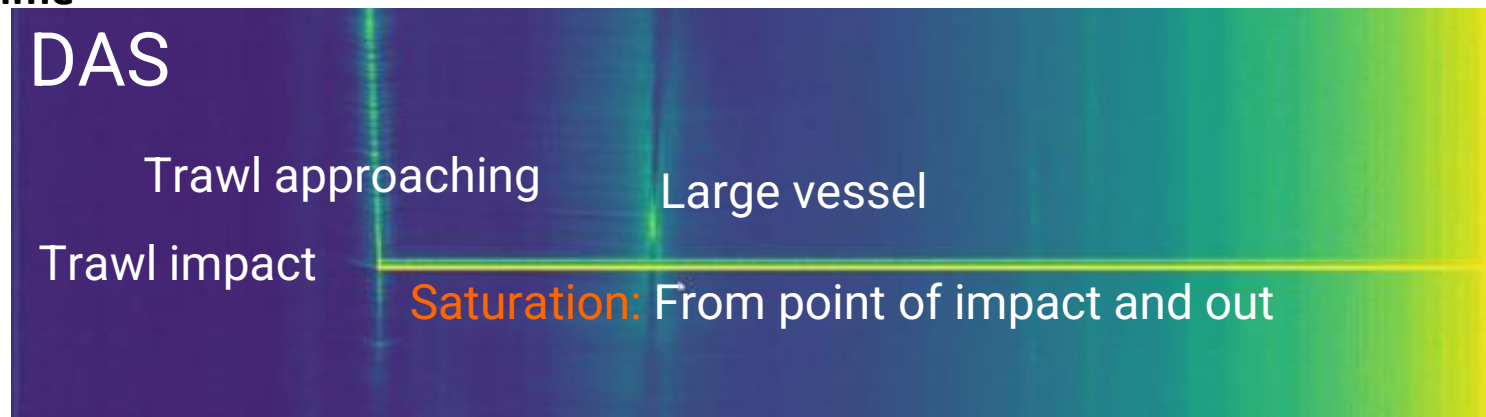


Detection and alarming of trawler hits (To be presented at OFC 2026)

Amplitude SoP variation



Time

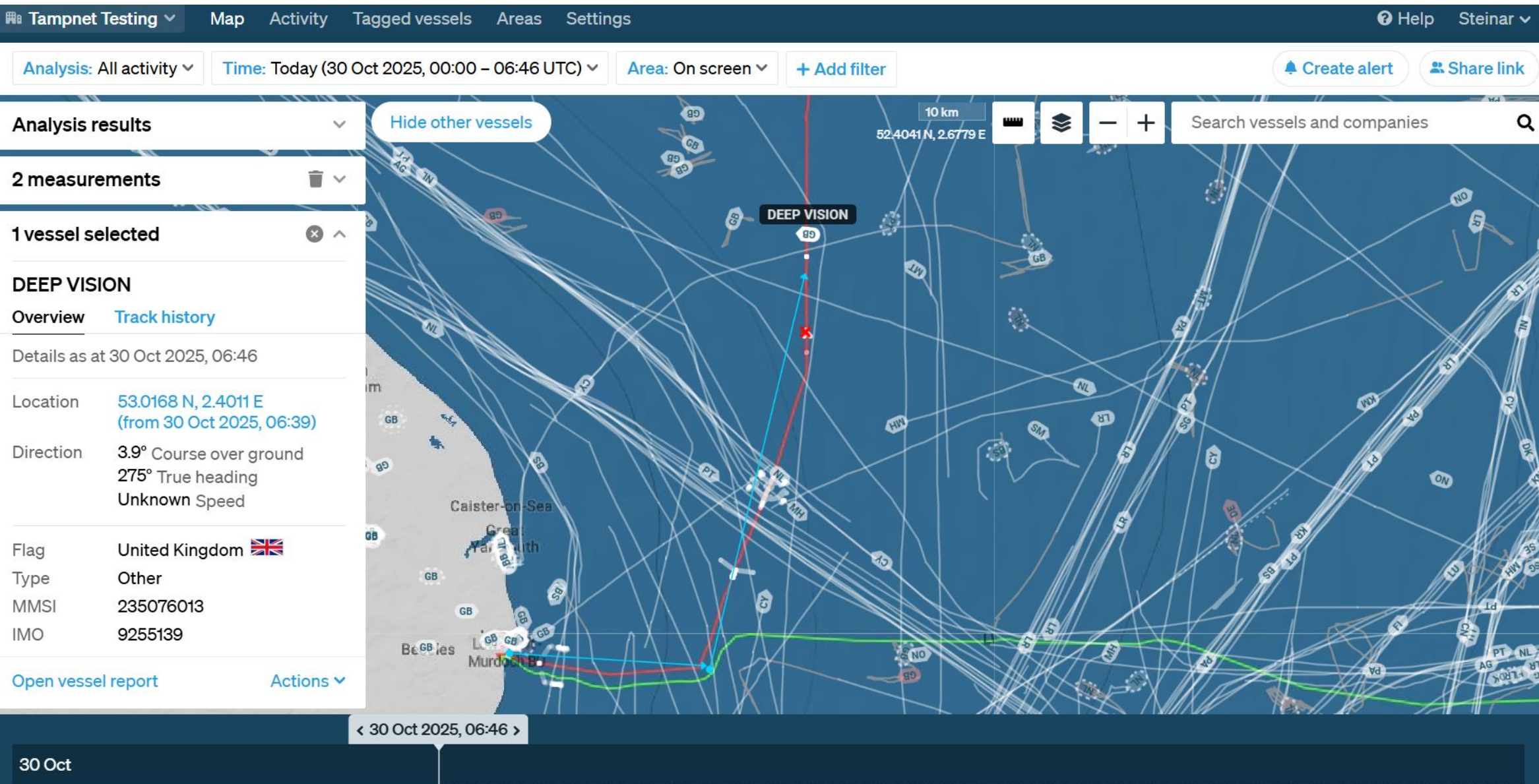


Distance along cable

- DAS detects trawls approaching
- Can be e.g. 10 trawl crossings every day over one cable
- SoP detects *hits* on the cable
- Separating close contact and fibre hit challenging with DAS

SoP: Promising technique for NOC alarming

Visualisation of AIS, DAS and SoP in Starboard

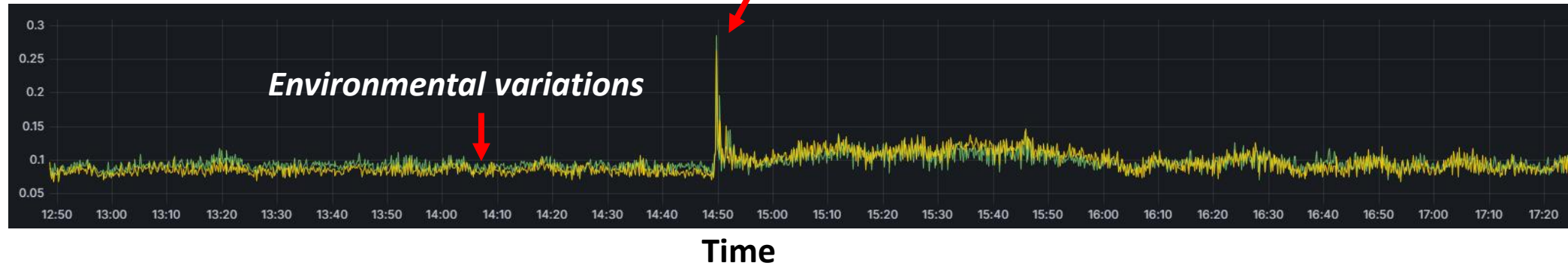


The screenshot displays the Starboard interface with the following elements:

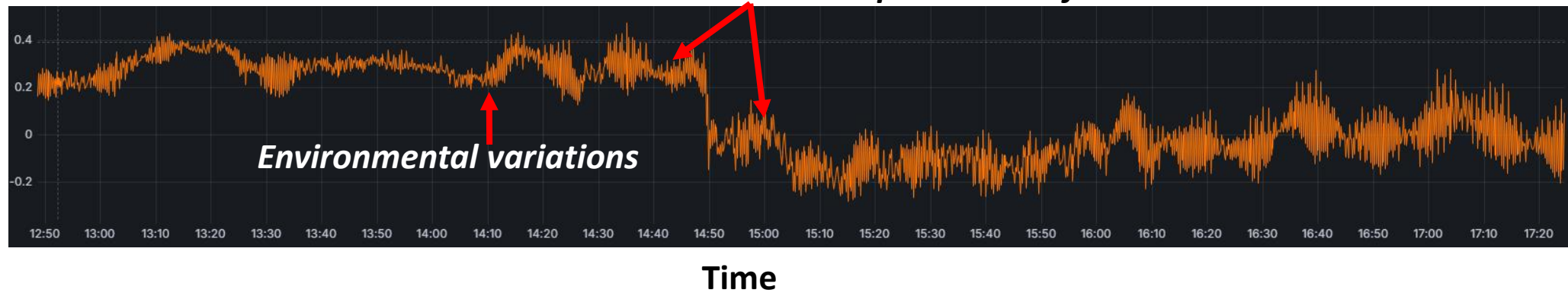
- Navigation Bar:** Tampnet Testing, Map, Activity, Tagged vessels, Areas, Settings, Help, Steinar.
- Filters:** Analysis: All activity, Time: Today (30 Oct 2025, 00:00 – 06:46 UTC), Area: On screen, + Add filter.
- Map:** Shows vessel tracks and positions. A vessel named "DEEP VISION" (MMSI 235076013) is highlighted with a red track. Other vessels are shown with grey tracks and callouts.
- Left Panel (Vessel Details for DEEP VISION):**
 - Analysis results:** 2 measurements.
 - 1 vessel selected:** DEEP VISION.
 - Overview / Track history:** Details as at 30 Oct 2025, 06:46.
 - Location:** 53.0168 N, 2.4011 E (from 30 Oct 2025, 06:39).
 - Direction:** 3.9° Course over ground, 275° True heading, Unknown Speed.
 - Flag:** United Kingdom (UK).
 - Type:** Other.
 - MMSI:** 235076013.
 - IMO:** 9255139.
 - Actions:** Open vessel report, Actions.
- Map Controls:** 10 km scale, search bar "Search vessels and companies", zoom in (+) and zoom out (-) buttons.
- Bottom Bar:** Date and time: 30 Oct, 30 Oct 2025, 06:46.

Change detection: Detecting cable displacement

Dynamic SoP variation



Static SoP



SoP Earthquake observation M 4.2 -KDDI Japan (Research)

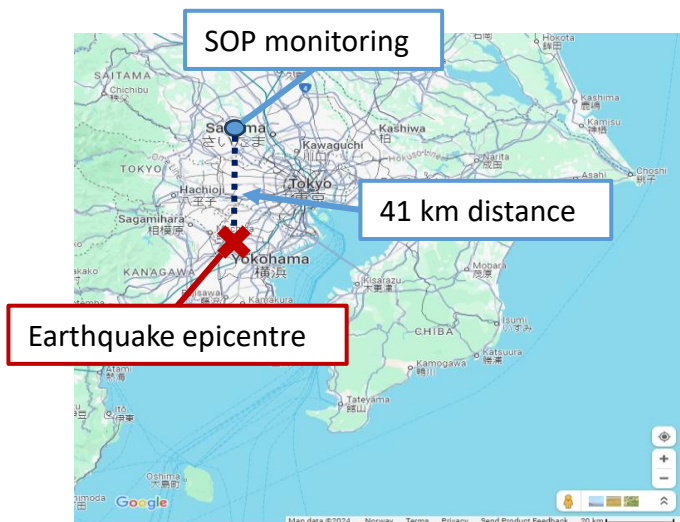
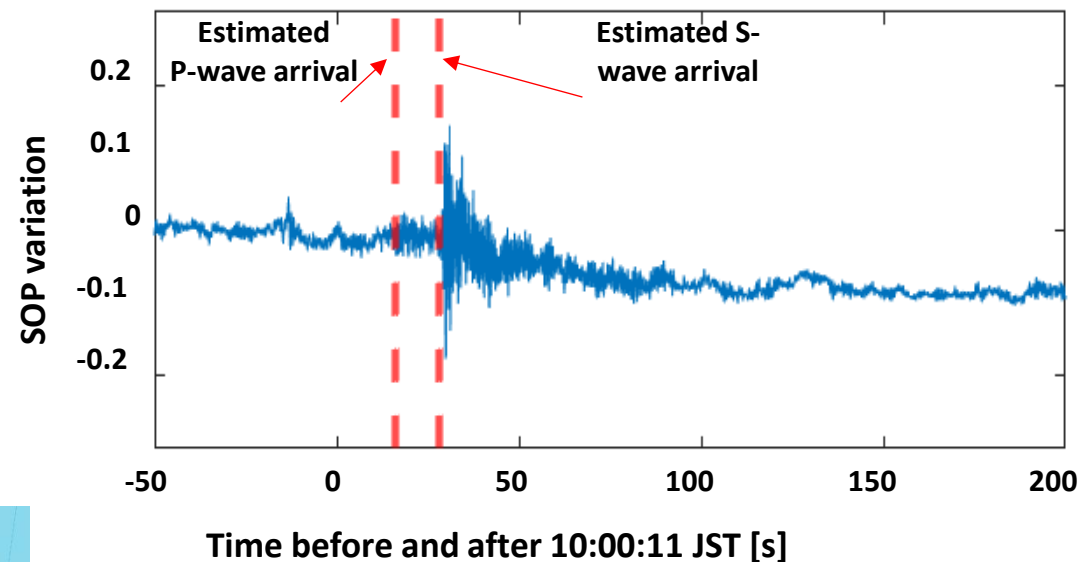
K. S. Y. Skarvang, D. J. Elson, S. Beppu, D. Soma, S. Bjørnstad, D. R. Hjelm and Y. Wakayama, "Earthquake Detection using State-of-Polarisation Sensing on Aerial Cable," *50th European Conference on Optical Communications (ECOC 2024)*, Frankfurt, Germany, 2024.



363m aerial cable

Estimated Earthquake arrival time:

P-wave (7 km/s): 16.1 seconds
S-wave (4 km/s): 28.3 seconds
(Propagation distance 113 km)



16X frequency pitch

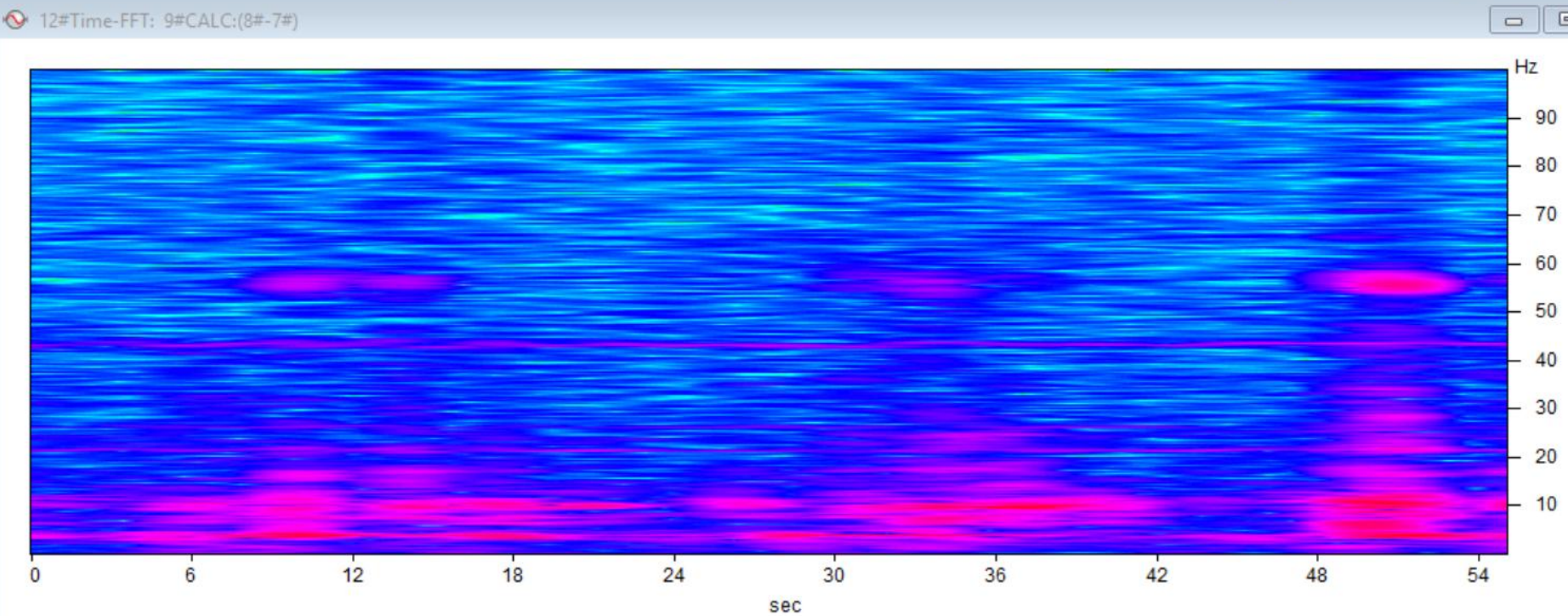


64X frequency pitch

Example: Excavator digging



Frequency spectrogram analyzing raw data

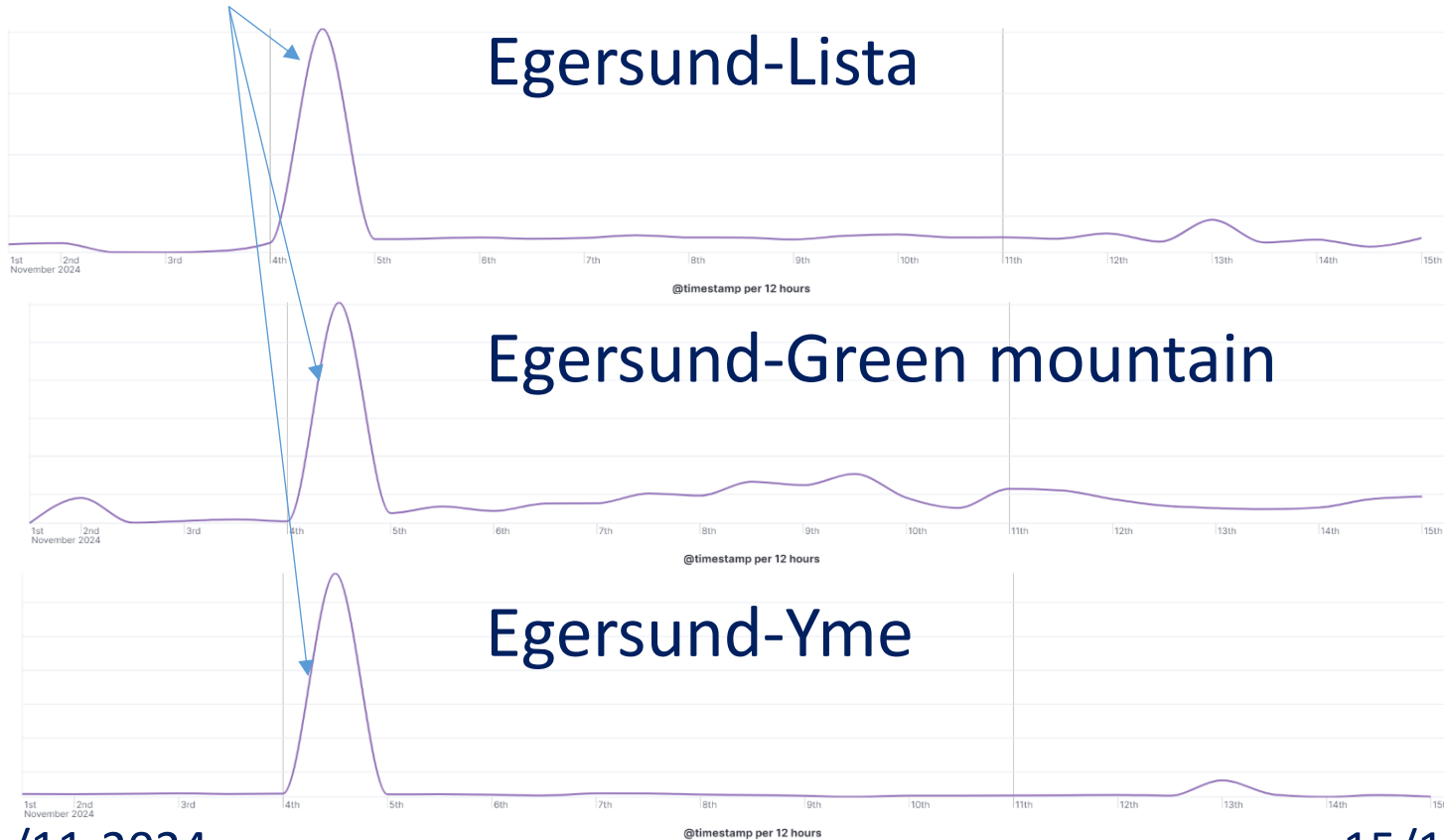


Up to 60 Hz observed

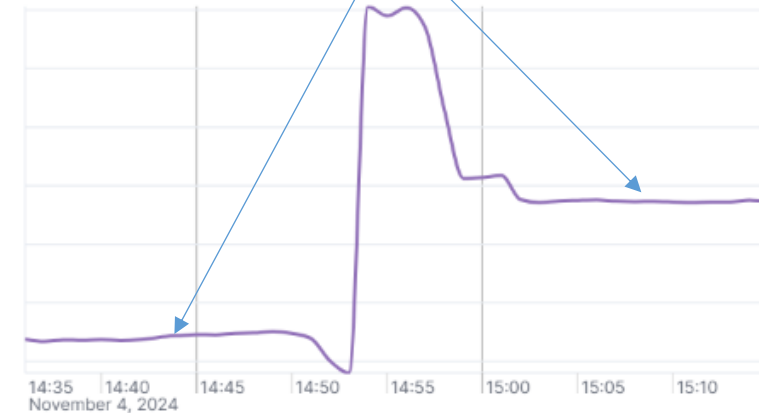
SoP: Location of physical impact

- Example from Egersund: Monitoring (planned) work in node room.
- Activity detected on three cable paths simultaneously
- Timing-based localisation approaches struggles with a integrated signal with low frequency components from impacts compared to propagation delay: Low SNR and Inaccuracy

Activity 4/11 kl.1453



Permanent change in physical position of fibre



1/11-2024

15/11-2024

TamperFighter: A scalable physical layer Cyber security fibresensing solution

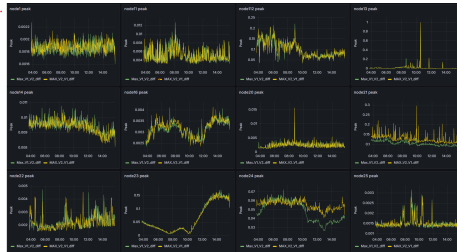
Summary

SoP HW

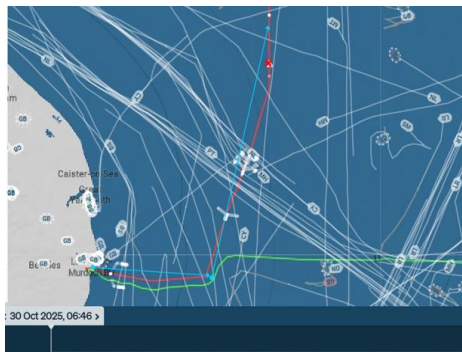


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Real-time GUI and alarms



AIS, DAS, SoP Combined In Starboard map



- Real-time GUI plot – local and centralized storage of raw data - scalability
- Main use-case: Optical path change detection: Alarming
- Compatibility: Standardized output format, easy integration with tools, e.g. Graphana, correlation with e.g. DAS and AIS data